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TECHNICAL REPORT

73-6-FL

EFFECT OF REHYDRATION AND COOKING PARAMETERS ON THE TENDERNESS OF FREEZE-DRIED RAW PORK CHOPS

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May 1972

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760

U.S. ARMY MATERIEL COMMAND

Food Laboratory

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PROJECT REFERENCE
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FOREWORD

Freeze-dried raw pork chops are purchased by the Armed Services for the B-ration and for special purposes. Complaints have been received from the field indicating the chops were considered tougher than they should be.

It has been shown that freeze-dried meats are generally tougher than the equivalent fresh or frozen meats. Studies concerned with dehydration and predehydration variables have shown that while some improvements can be made in these areas, any such improvements will not overcome the field complaints. Since rehydration and cooking procedures are known to have some effect on tenderness, this study was conducted to obtain definitive information in these areas.

The work was performed under project 1J662713A034, Military Food Service and Subsistence Technology.

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ABSTRACT

A full factorial study was conducted with freeze-dried raw pork chops in which the chops were rehydrated at three different temperatures (27°, 38°, 49°C), equilibrated before cooking for three periods (0, 4, 24 hours), cooked by two different methods (fry, bake), and coated in three different ways (none, flour, breading). The cooked products were evaluated for tenderness by a technological taste panel and penetrometer readings and for water retention during cooking.

Analysis of variance indicated that the use of a coating increased the tenderness of the cooked product appreciably without a substantial increase in cooking time and that breading was more effective than flour alone. Rehydration water temperature and cooking methods had statistically significant effects on the tenderness, but accounted for only small percentages of the total variance observed. Rehydration equilibration time was not statistically significant. Water retained in the product during cooking was linearly correlated with tenderness ($r = .5$).

INTRODUCTION

It is generally recognized that freeze-dried meat is tougher than the equivalent fresh or frozen meat. Complaints from the field regarding freeze-dried raw pork chops have indicated that toughness is a significant problem. Tuomy and Helmer (1967) showed that freeze-dried raw pork was substantially tougher than the fresh frozen although there were wide variations between the various loins used in the study. Studies have shown that freeze-drying conditions affect the quality of freeze-dried meats (Tuomy and Felder, 1964; Tuomy et al. 1962). A recent study specifically on freeze-dried raw pork chops (Brown et al. 1972) found that dehydrator pressure and temperature had statistically significant effects on the product tenderness. However, these effects were generally small in comparison to the effects caused by storage temperature and time. It was indicated that rehydration and cooking procedures could be major factors in the tenderness of the cooked product. Tuomy and Lechnir (1964) showed that cooking temperatures and times could have considerable effects on the final tenderness of pork although freeze-drying was not used in this study.

It has been postulated that the water of rehydration in freeze-dried meat is not as tightly held as it is in normal meat. Therefore, it will be driven off more easily during cooking resulting in drying and toughening. If this is true, the cooking procedures should have a marked effect on the final quality. Szczesniak et al. (1965) noted that the method of rehydration did appear to have an effect on the water retention, but did not develop this observation any further.

EXPERIMENTAL METHODS

Fresh bone-in pork loins (12-14 lbs) were obtained from midwestern sources. The *longissimus dorsi* muscle was dissected from each loin, stuffed into 8.25 cm casings, and frozen in a blast freezer at -29°C. After freezing, the muscles were cut into 0.95 cm thick discs. The discs were cut into 6.4 cm circles with a drill press and cutter and returned to the -29°C freezer. All of the frozen discs were completely mixed to achieve randomization and freeze-dried with radiant heat, a platen temperature of 43°C and a dehydrator pressure of 200 - 400 microns. After freeze-drying the discs were placed in 300 x 200 cans, three per can. The cans were evacuated and flushed back with nitrogen three times before sealing and then stored at 4°C until used.

The study was designed as a full factorial with three replications. Factors and levels used were: A. rehydration water temperature (27°, 38° and 49°C); B. rehydration equilibration time (0, 4, 24 hours); C. coatings (none, flour, breading); and D. cooking methods (fry, bake).

The pork slices were rehydrated in a constant temperature water bath for 20 minutes being turned over at the end of 10 minutes so that the "dry" side was down for the final 10 minutes. The bath was maintained at ± 0.6°C. After rehydration, the slices were drained on a plastic screen with 3.2 mm square openings. The rehydrated slices were placed in covered glass petri dishes and held in a 4°C box. Zero rehydration equilibration time was considered as the point at which the slices reached a temperature of 4°C. approximately 30 minutes after completion of rehydration.

The flour coated slices were dredged in wheat flour by hand to obtain as uniform coating of flour as possible. The breaded slices were first dipped in Modern Maid Batter Mix 4113 and then coated with Modern Maid Redi-Breader 1149. Frying was accomplished in an electric frypan at 190° ± 3.8°C with 10 cc

of corn oil. The floured and breaded slices were fried $2\frac{1}{4}$ min per side to an approximate internal temperature of 77°C. The slices with no coating were fried 2 min per side to the same internal temperature. Baking was accomplished in a reel oven at 163°C. Slices with no coating were held in the oven $12\frac{1}{2}$ min and the coated slices 10 min to give an approximate internal temperature of 77°C.

The slices were penetrated, using an L.E.E. Kramer Shear Press modified and used according to the procedures of Hinnergardt and Tuomy (1970). All slices were penetrated before and after cooking. Coatings were removed by scraping before the cooked chops were penetrated. All evaluations were done with the slices at an internal temperature of 4°C. The maximum reading in the time-force curve was used for the analysis.

Taste panel evaluation was made by a 10-member technological panel rating the product on a 9-point scale for tenderness only where the highest number was the most acceptable. The same panel was used for all evaluations. The product penetrated after cooking was used for panel evaluations.

RESULTS AND DISCUSSION

Averages of the data obtained are shown in Tables 1 thru 4. Tables 3 and 4 give two different aspects of moisture retention during cooking. Table 3 shows the percent water in the final cooked product whereas Table 4 shows the percent of total water of rehydration lost during cooking. Analysis of variance results along with percents of variance are shown in Table 5.

Analysis for penetrometer results in Table 5 was made on the difference between readings on the same slice raw and cooked. The coatings and cooking methods x coatings interaction were both significant at the 1 percent level, and together accounted for 77.8 percent of the observed variance with coatings alone accounting for 65.4 percent. Using the Duncan Multiple Range Test (Duncan, 1955), it is found that there is a statistically significant difference between all three of the coating means with increased tenderness occurring with increased amount of coating. Both rehydration water temperature and cooking methods were statistically significant at the 5 percent level, but only accounted for small percentages of the observed variance. With water temperature, the most tender product occurred with the lower temperature. With cooking methods, frying produced the most tender product. The cooking methods x coatings interaction was significant at the 1 percent level. Inspection of the interaction sums (Table 6) shows that (1) frying results in a significantly tougher product than baking when no coatings are used and (2) the use of coatings has a much greater tenderizing effect with the fried product than it does with the baked. The net result was that the frying main effect showed up in the analysis as producing the most tenderness. In this case the interaction is more important than the main effect.

The analysis of taste panel results for tenderness showed statistically significant results for rehydration water temperature, coatings, and the rehydration water temperature x rehydration equilibration time. As with the penetrometer readings, the lowest rehydration water temperature and the heavier coatings produced the most tender products. With the interaction the combination of breading and 24 hours equilibration time produced the most tender product. However, considering that the rehydration equilibration time sums were not linear and the penetrometer did not show this interaction as significant, it is evident that more work is needed before the significance of the effect can be firmly established.

While both, the water retained in the cooked product and the percent of total water picked up in rehydration lost during cooking, linearily correlate with both penetrometer readings and taste panel results with correlation coefficients of approximately 0.5, the two values do not tie in with penetrometer and taste panel results too well on a practical basis. Cooking methods account for much more of the variance and the rehydration water temperature x coatings is considerably higher particularly with the rehydration water lost. The water should be a much more important factor in other organoleptic attributes such as flavor and mouth feel.

It has been recognized for some time that freeze-drying toughens meat and that extra cooking is needed to overcome this toughness. Baking or steaming are two ways in which it may be overcome. However, it is evident from this study that freeze-dried pork chops can be grilled to an acceptable tenderness provided a coating or breading is used.

REFERENCES

Brown, C. L., H. W. Shafer, and J.M. Tuomy, 1972. Effect of Freeze-Drying Conditions on the Quality of Raw Pork. NLABS Technical Report 71-41-FL.

DeFelice, D., Alina Szczesniak, E. Farcas, D. Gardner, K. Slomen, John D. Kapsalis and Justin Tuomy. 1965. Fundamental Aspects of Meat Texture. NLABS Technical Report FD-17.

Duncan, David B. 1955. Multiple Range and Multiple F Tests. Biometrics 1-41 (March).

Hinnergardt, L. C. and J. M. Tuomy. 1970. A Penetrometer Test to Measure Meat Tenderness. J. Fd. Sci 35, 312.

Tuomy, J.M. and Jack Felder. 1964. Effect of Processing Temperatures and Cooking Methods on the Quality of Freeze-Dried Pork. Food Tech 18, 135-136.

Tuomy, J.M., and R. L. Helmer. 1967. Effect of Freeze-Drying on the Quality of the Longissimus Dorsi Muscle of Pork. Food Tech. 21, 167-169.

Tuomy, J.M. and R. J. Lechnir. 1964. Effect of Cooking Temperature and Time on the Tenderness of Pork. Food Tech. 18, 97-100.

Tuomy, J.M., R.J. Lechnir and Terrance Miller. 1962. Effect of Dehydration Variables on the Quality of Freeze-Dried Cooked Sliced Beef. QMC&CIAF Report No. 14-62.

TABLE 1. AVERAGE DIFFERENCE BETWEEN RAW AND COOKED PENETROMETER READINGS IN KILOGRAMS

COOKING METHOD	COATING	REHYDRATION WATER TEMP (°C) 27			38			49		
		REHYDRATION EQUILIBRATION TIME (HRS)								
		0	4	24	0	4	24	0	4	24
FRY	NONE	2.99	4.54	3.13	3.22	3.54	2.90	4.67	2.63	3.86
	FLOUR	1.95	2.09	1.77	1.81	1.41	1.68	0.68	0.32	1.27
	BREAD	1.50	1.04	1.63	1.50	1.41	1.09	0.50	0.82	1.13
BAKE	NONE	2.72	2.99	3.18	2.86	3.36	2.81	3.04	3.08	2.63
	FLOUR	1.91	2.22	2.18	1.86	2.63	3.36	1.91	2.09	1.45
	BREAD	1.50	2.09	2.18	1.91	0.86	1.77	1.59	1.68	1.36

TABLE 2. AVERAGE TECHNOLOGICAL RESPONSES ON A 9-POINT SCALE

COOKING METHOD	COATING	REHYDRATION WATER TEMP (0°C) 27			38			49		
		REHYDRATION EQUILIBRATION TIME (HRS) 0	4	24	0	4	24	0	4	24
	NONE	6.0	5.0	8.2	5.7	4.3	6.0	3.1	4.9	4.2
FRY	FLOUR	6.0	5.9	6.4	6.2	5.8	6.1	5.7	6.2	4.8
	BREAD	6.2	6.9	7.1	6.4	6.2	6.7	7.4	6.5	5.6
	NONE	6.0	5.3	5.8	5.8	4.9	5.1	4.7	5.8	3.5
BAKE	FLOUR	6.3	5.1	7.2	6.2	5.1	5.1	4.9	5.5	7.0
	BREAD	6.4	5.5	5.8	6.6	7.0	6.5	4.8	5.4	5.5

TABLE 3. AVERAGE PERCENT WATER IN COOKED PRODUCT

		REHYDRATION WATER TEMP (°C)								
		27			38			49		
COOKING METHOD	COATING	REHYDRATION EQUILIBRATION TIME (HRS)								
		0	4	24	0	4	24	0	4	24
FRY	NONE	52.0	53.6	56.3	53.0	51.8	54.5	50.6	49.5	49.6
	FLOUR	53.2	55.0	57.8	52.4	53.3	53.7	59.5	58.6	50.7
	BREAD	62.6	59.8	59.6	57.2	57.3	60.6	59.1	59.1	58.1
BAKE	NONE	56.0	50.2	52.9	49.2	51.1	53.6	50.5	48.7	52.7
	FLOUR	53.6	55.2	56.6	48.5	50.0	48.8	48.1	48.1	55.8
	BREAD	55.3	55.0	52.0	51.6	57.4	54.0	54.5	51.5	52.8

TABLE 4. AVERAGE PERCENT OF REHYDRATION WATER LOST DURING COOKING

COOKING METHOD	COATING	REHYDRATION WATER TEMP (0°C) 27			38			49		
		REHYDRATION EQUILIBRATION TIME (HRS)								
		0	4	24	0	4	24	0	4	24
	NONE	49.5	54.5	47.5	45.8	52.5	50.0	50.9	57.3	52.3
FRY	FLOUR	48.4	52.9	43.6	52.8	53.8	50.3	30.2	30.5	50.1
	BREAD	37.7	44.2	38.6	43.5	43.4	38.3	35.8	26.8	27.7
	NONE	43.1	58.5	57.2	55.2	56.2	50.1	49.5	54.1	48.8
BAKE	FLOUR	54.8	50.4	43.2	61.5	56.2	62.5	52.9	56.0	35.8
	BREAD	44.0	49.2	55.2	44.5	49.8	52.2	38.0	45.6	44.0

TABLE 5. ANALYSIS OF VARIANCE RESULTS AND PERCENT OF TOTAL VARIANCE

FACTOR	PENETROMETER SIG	PENETROMETER % VAR	TASTE PANEL SIG	TASTE PANEL % VAR	WATER RETAINED SIG	WATER RETAINED % VAR	REHY WATER LOSS SIG	REHY WATER LOSS % VAR
A REHY H_2O TEMP	*	2.2	**	26.6	**	7.9	**	9.5
B REHY EQUIL TIME	n.s.	-	n.s.	-	n.s.	-	*	1.3
C COOKING METHODS	*	1.4	n.s.	-	**	26.7	**	12.1
D COATINGS	**	65.4	**	36.4	**	29.3	**	17.6
AB	n.s.	-	**	8.4	n.s.	-	n.s.	-
AC	n.s.	-	n.s.	-	n.s.	-	n.s.	-
AD	*	3.6	n.s.	-	*	5.2	**	32.2
BC	n.s.	-	n.s.	-	n.s.	-	n.s.	-
BD	n.s.	-	n.s.	-	n.s.	-	n.s.	-
CD	**	15.0	n.s.	-	**	14.4	**	5.3
REMAINDER	-	12.4	-	28.2	-	16.5	-	22.0

* Significant at the 5% level.
** Significant at the 1% level.
n.s. Not significant at the 5% level.

TABLE 6. COOKING METHOD X COATINGS INTERACTION SUMS - DIFFERENCE BETWEEN RAW AND COOKED PENETROMETER READINGS IN KILOGRAMS

	Frying (C_o)	Baking (C_1)
No Coating (D_o)	283.2	240.0
Flour (D_1)	116.8	176.4
Breading (D_2)	96.3	134.5

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13. ABSTRACT

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Cooking Devices	6					
Temperature	6					
Moisture Content	7					
Tenderness	7					
Acceptability	7					
Coatings	6					